Interactions of ionizable pharmaceutical pollutants in water with carbon nanotubes and titanium dioxide

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Ibuprofen is among the most widely used pharmaceuticals, leading to its frequent occurrence as an emerging organic pollutant in surface water bodies. Ibuprofen, along with other ionizable organic pharmaceuticals, are poorly removed during conventional municipal wastewater treatment plants, and, therefore, they are introduced into the environment upon discharge of treated wastewater to rivers and streams. Meanwhile, the recent wide-spread inclusion of novel materials like carbon nanomaterials and photocatalysts in commercial household product formulations, leads to the possibility of interactions between ionizable organic pollutants and these materials, both in the municipal wastestream and the natural aqueous environment.

In this study, using ibuprofen as a model ionizable organic pollutant, its interactions with multiwalled carbon nanotubes (MWCNTs) and titanium dioxide (TiO_2) photocatalyst were explored in aqueous systems. Sorptive interactions between ibuprofen and MWCNTs and TiO_2 were studied as a function of water chemistry (e.g., pH and ionic strength), presence/absence of light, and sorbent crystallinity and surface charge. In addition, careful sorption kinetics and equilibrium experiments were run with MWCNTs immobilized as a water-permeable networked filterbed or as a non-spongy water-permeable foam, in order to remove the unpredictable and confounding effect of CNT aggregation with changing water chemistry. The effects of TiO_2 reactivity, with its changing morphology and crystallinity, on the generation of photocatalyic oxidation products from ibuprofen was also attempted.